Radiation characteristics of a slot antenna on the cylindrical surface

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Abstract

A cylindrical array antenna is very useful in many applications such as phased array for radar and base station antenna for mobile communications. The advantage of this antenna type is that the structure is conformal and it can be installed to be the portion of many parts of vehicles such as aircraft, spacecraft and missiles. Its structure is symmetry along the cylindrical axis that makes the pattern symmetrically radiated. In addition, the development of the cylindrical array that is cost effective is very important. Instead of mounting the array elements such as dipole, turnstile or microstrip patch on the cylindrically conducting surface, the authors propose to cut the slot as the array elements on the cylindrical surface. In the investigation of the cylindrical slot array antenna, the radiation field radiated from a single slot on cylindrical surface must be first known.

This paper presents the radiation characteristics of a slot antenna on the cylindrical surface. The geometry of the problem consists of the slot of the length l aligned on the z axis at the outer surface of the cylindrical structure of the radius a. The slot width (w) is very narrow in order that the electric field has single polarization along the width of the slot. Radiation characteristics such as radiation pattern, half-power beamwidth, front-to-back ratio and directivity of a slot on the cylindrical surface are investigated theoretically. The electromagnetic fields, which are utilized to excite the slot based on the entire modes. The total fields inside the cavity are formulated by means of the combination of TE and TM modes. The unknown coefficients of the fields are determined by imposing the boundary conditions. The voltage distribution along the slot is reasonably considered to be a sinusoidal function. The exterior radiation fields can be determined by using the asymptotic method together with the continuous field at the slot. The numerical results of radiation characteristics for various radii of the cylinder are demonstrated. The radiation pattern and half power beamwidth is shown in xy-, xz-, yz- planes, respectively. It is apparent that the half power beamwidth is very wide for the small radius and it becomes narrower as the radius is increased. When the radius is very large the half power beamwidth of the slot on the cylindrical surface tends to have the similar characteristics with the slot on the ground plane. The front to back ratio of the antenna is monotonically increased as the radius of the cylinder is further increased. From this viewpoint, it can be expected that the level of the back lobe will reduce when the cylindrical radius becomes large. The most significant characteristic of the antenna i.e., the directivity is illustrated for various cylindrical radii. It is evident that the directivity can be enhanced when the radius is larger. The directivity approaches the certain value of 6.06 dBi when the radius is larger than 0.95 of the operating wavelength. The experiment is done to compare the result with the theoretical prediction. It is obvious that the result agrees satisfactorily. This antenna can be developed to be the element of the cylindrical slot array antenna for some applications such as base-station antenna for television broadcasting system.

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